### **Environmental Protection Agency**

the engine at normal operating temperatures as prescribed by the engine manufacturer.

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56995, Oct. 23, 1998]

#### §89.330 Lubricating oil and test fuels.

- (a) Lubricating oil. Use the engine lubricating oil for testing that meets the requirements as specified by the manufacturer for a particular engine and intended usage. Record the specifications of the lubricating oil used for the test.
- (b) Test fuels. (1) Use diesel fuels for testing which are clean and bright, with pour and cloud points adequate for operability. The diesel fuel may contain nonmetallic additives as follows: Cetane improver, metal deactivator, antioxidant, dehazer, antirust, pour depressant, dye, dispersant, and biocide.
- (2) Use petroleum fuel meeting the specifications in Table 4 in Appendix A of this subpart, or substantially equivalent specifications approved by the Administrator, for exhaust emission testing. The grade of diesel fuel used must be commercially designated as "Type 2-D" grade diesel fuel and recommended by the engine manufacturer.
- (3) Testing of Tier 1 and Tier 2 engines rated under 37 kW and Tier 2 and Tier 3 engines rated at or above 37 kW that is conducted by the Administrator shall be performed using test fuels that meet the specifications in Table 4 in Appendix A of this subpart and that have a sulfur content no higher than 0.20 weight percent.
- (c) Other fuels may be used for testing provided they meet the following qualifications:
  - (1) They are commercially available;
- (2) Information acceptable to the Administrator is provided to show that only the designated fuel would be used in customer service;
- (3) Use of a fuel listed under paragraph (b) of this section would have a detrimental effect on emissions or durability; and
- (4) Fuel specifications are approved in writing by the Administrator prior to the start of testing.
- (d) Report the specification range of the fuel to be used under paragraphs (b)(2) and (c)(1) through (c)(4) of this

- section in the application for certification in accordance with §89.115 (a)(8).
- (e) Low-sulfur test fuel. (1) Upon request, for engines rated at or above 75 kW in model years 2006 or 2007, the diesel test fuel may be the low-sulfur diesel test fuel specified in 40 CFR part 1065, subject to the provisions of this paragraph (e)(1).
- (i) To use this option, the manufacturer must—
- (A) Ensure that ultimate purchasers of equipment using these engines are informed that the use of fuel meeting the 500 ppm specification is recommended.
- (B) Recommend to equipment manufacturers that a label be applied at the fuel inlet recommending 500 ppm fuel.
- (ii) None of the engines in the engine family may employ sulfur-sensitive technologies.
- (iii) For engines rated at or above 130 kW, this option may be used in 2006 and 2007. For engines rated at or above 75 kW and under 130 kW, this option may be used only in 2007.
- (2) For model years 2008 through 2010, except as otherwise provided, the diesel test fuel shall be the low-sulfur diesel test fuel specified in 40 CFR part 1065.
- (3) The diesel test fuel shall be the ultra low-sulfur diesel test fuel specified in 40 CFR part 1065 for model years 2011 and later.
- (4) For model years 2007 through 2010 engines that use sulfur-sensitive emission-control technology, the diesel test fuel is the ultra low-sulfur fuel specified in 40 CFR part 1065 if the manufacturer demonstrates that the in-use engines will use only fuel with 15 ppm or less of sulfur.
- (5) Instead of the test fuels described in paragraphs (e)(2) through (4) of this section, for model years 2008 and later, manufacturers may use the test fuel described in appendix A of this subpart. In such cases, the test fuel described in appendix A of this subpart shall be the test fuel for all manufacturer and EPA testing.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57013, Oct. 23, 1998; 69 FR 39213, June 29, 2004]

## §89.331 Test conditions.

(a) General requirements. Calculate all volumes and volumetric flow rates at

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standard conditions for temperature and pressure (0  $^{\circ}$ C and 101.3 kPa), and these conditions must be used consistently throughout all calculations.

(b) Engine test conditions. Measure the absolute temperature (designated as T and expressed in Kelvin) of the engine air at the inlet to the engine, and the dry atmospheric pressure (designated as p and expressed in kPa), and determine the parameter f according to the following provisions:

(1) Naturally aspirated and mechanically supercharged engines:

$$f = \frac{99}{p_s} \times \left(\frac{T}{298}\right)^{0.7}$$

(2) Turbocharged engine with or without cooling of inlet air:

$$f = \left(\frac{99}{p_s}\right)^{0.7} \times \left(\frac{T}{298}\right)^{1.5}$$

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(c) For a test to be recognized as valid, the parameter f shall be between the limits as shown below:

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56995, Oct. 23, 1998]

APPENDIX A TO SUBPART D OF PART 89— TABLES

TABLE 1-ABBREVIATIONS USED IN SUBPART D

CLD	Chemiluminescent detector.	
CO	Carbon monoxide.	
CO <sub>2</sub>	Carbon dioxide.	
HC	Hydrocarbons.	
HCLD	Heated chemiluminescent detector.	
HFID	Heated flame ionization detector.	
GC	Gas chromatograph.	
NDIR	Non-dispersive infra-red analyzer.	
NIST	National Institute for Standards and Testing.	
NO	Nitric Oxide.	
NO <sub>2</sub>	Nitrogen Dioxide.	
NO <sub>x</sub>	Oxides of nitrogen.	
O <sub>2</sub>	Oxygen.	

TABLE 2—SYMBOLS USED IN SUBPARTS D AND E

$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Symbol	Term	Unit
FreB   Fuel specific factor for the carbon balance calculation   Fuel specific factor for exhaust flow calculation on dry basis   Fuel specific factor representing the hydrogen to carbon ratio   Fuel specific factor representing the hydrogen to carbon ratio   Fuel specific factor for exhaust flow calculation on wet basis   Rate of fuel consumed   g/h   Intake air mass flow rate on wet basis   kg/h   Intake air mass flow rate on dry basis   kg/h   Intake air mass flow rate on dry basis   kg/h   Kg/h   Exhaust gas mass flow rate on wet basis   kg/h   Kg/h   Exhaust gas mass flow rate on wet basis   kg/h   Kg/h   Holden   Kg/h   Kg/h   Holden   Kg/h   Kg/h   Holden   Kg/h   Kg/h   Holden   Kg/h   Holden   Kg/h	conc	Concentration (ppm by volume)	ppm
Feb. Full specific factor for exhaust flow calculation on dry basis Feh. Full specific factor representing the hydrogen to carbon ratio Feb. Full specific factor representing the hydrogen to carbon ratio Feb. Full specific factor for exhaust flow calculation on wet basis FR Rate of fuel consumed	f	Engine specific parameter considering atmospheric conditions	
Feru Fuel specific factor representing the hydrogen to carbon ratio Ferw Fuel specific factor for exhaust flow calculation on wet basis FR Rate of fuel consumed	F <sub>FCB</sub>	Fuel specific factor for the carbon balance calculation	
Few Rate of fuel consumed ghamber of the consumer of t	F <sub>FD</sub>	Fuel specific factor for exhaust flow calculation on dry basis	
FR	F <sub>FH</sub>		
GAIRW     Intake air mass flow rate on wet basis     Kg/h       GAIRD     Intake air mass flow rate on dry basis     kg/h       GEXHW     Exhaust gas mass flow rate on wet basis     kg/h       GFuel     Fuel mass flow rate     kg/h       H     Absolute humidity (water content related to dry air)     g/kg       i     Subscript denoting an individual mode       KH     Humidity correction factor     Werenent torque related to maximum torque for the test mode     %       Mass     Pollutant mass flow     g/h       Pollutant mass flow     g/h       Pal     Engine speed (average at the i'th mode during the cycle)     1/min       Ps     Dry atmospheric pressure     kPa       Pd     Test ambient saturation vapor pressure at ambient temperature     kPa       Pal     Observed brake power output uncorrected     kW       PALUX     Declared total power absorbed by auxiliaries fitted for the test     kW       PALUX     Declared total power measured at the test speed under test conditions     kW       Pi     Pi = Pm. i + Paux.i     kW       PB     Total barometric pressure (average of the pre-test and post-test values)     kPa       Ps     Saturation pressure at dew point temperature     kPa       Relative humidity of the ambient air     %       S     Dynamometer setting <td>F<sub>FW</sub></td> <td>Fuel specific factor for exhaust flow calculation on wet basis</td> <td></td>	F <sub>FW</sub>	Fuel specific factor for exhaust flow calculation on wet basis	
GAIRD GENEW         Intake air mass flow rate on dry basis         kg/h kg/h kg/h           GEXHW         Exhaust gas mass flow rate on wet basis         kg/h kg/h           H         Absolute numidity (water content related to dry air)         g/kg           i         Subscript denoting an individual mode         y/kg           KH         Humidity correction factor         y/kg           L         Percent torque related to maximum torque for the test mode         %           mass         Pollutant mass flow         g/h           nd, i         Engine speed (average at the i'th mode during the cycle)         1/min           Ps         Dry atmospheric pressure         kPa           Pd         Test ambient saturation vapor pressure at ambient temperature         kPa           P         Observed brake power output uncorrected         kW           Paux         Declared total power absorbed by auxiliaries fitted for the test         kW           PM         Maximum power measured at the test speed under test conditions         kW           PM         Maximum power measured at the test speed under test values)         kW           P <sub>1</sub> = P <sub>M, 1</sub> + P <sub>AUX, 1</sub> kW           P <sub>2</sub> Saturation pressure at dew point temperature         kPa           P <sub>2</sub> Saturation pressure (average of the pre-test and post-test values) <td>FR</td> <td>Rate of fuel consumed</td> <td>g/h</td>	FR	Rate of fuel consumed	g/h
GEXHW       Exhaust gas mass flow rate on wet basis       kg/h         GFuel       Fuel mass flow rate       kg/h         H       Absolute humidity (water content related to dry air)       g/kg         i       Subscript denoting an individual mode       White the process of	G <sub>AIRW</sub>	Intake air mass flow rate on wet basis	kg/h
GFuel     Fuel mass flow rate     kg/h       H     Absolute humidity (water content related to dry air)     g/kg       i     Subscript denoting an individual mode       KH     Humidity correction factor     %       L     Percent torque related to maximum torque for the test mode     g/h       mass     Pollutant mass flow     g/h       Pollutant mass flow     g/h       L     Engine speed (average at the i'th mode during the cycle)     1/min       Ps     Dry atmospheric pressure     kPa       P - Test ambient saturation vapor pressure at ambient temperature     kPa       P - Test ambient saturation vapor pressure at ambient temperature     kW       Paulux     Declared total power absorbed by auxiliaries fitted for the test     kW       PALUX     Declared total power absorbed by auxiliaries fitted for the test     kW       PM     Maximum power measured at the test speed under test conditions     kW       Pi     Pi = Pm. i + Paux.i     kW       PB     Total barometric pressure (average of the pre-test and post-test values)     kPa       Relative humidity of the ambient air     %       S     Saturation pressure at dew point temperature     kPa       R     Absolute temperature at air inlet     K       T     Absolute temperature at air inlet     K       Total </td <td>G<sub>AIRD</sub></td> <td>Intake air mass flow rate on dry basis</td> <td>kg/h</td>	G <sub>AIRD</sub>	Intake air mass flow rate on dry basis	kg/h
H Absolute humidity (water content related to dry air)	G <sub>EXHW</sub>	Exhaust gas mass flow rate on wet basis	kg/h
i Subscript denoting an individual mode K <sub>H</sub> Humidity correction factor L Percent torque related to maximum torque for the test mode % mass Pollutant mass flow g/h  P <sub>4</sub> Pollutant mass flow g/h  P <sub>5</sub> Pollutant mass flow g/h  P <sub>6</sub> Test ambient saturation vapor pressure at ambient temperature kPa P <sub>7</sub> Deserved brake power output uncorrected kW  P <sub>8</sub> Declared total power absorbed by auxiliaries fitted for the test kW  P <sub>8</sub> Maximum power measured at the test speed under test conditions kW  P <sub>9</sub> P <sub>1</sub> = P <sub>M.1</sub> + P <sub>AUX.1</sub> P <sub>1</sub> Total barometric pressure (average of the pre-test and post-test values) kPa  R <sub>1</sub> Relative humidity of the ambient air %  S Dynamometer setting kW  T Absolute temperature at air inlet kT  Coolant temperature atter the charge air cooler (if applicable) (average) KT  Absolute devejonit temperature  K Total Absolute devejonit temperature  K Total Absolute devejonit temperature  K Total Absolute devejonit temperature  K Torque (average at the i'th mode during the cycle)  N-m  N-m  N-m  Reference temperature K  K Exhaust gas volume flow rate on dry basis  m³/h  VARW  Exhaust gas volume flow rate on wet basis  m³/h  Total barometric pressure  Exhaust gas volume flow rate on wet basis  m³/h  VENHW  Exhaust gas volume flow rate on wet basis  m³/h  Exhaust gas volume flow rate on wet basis  m³/h  Exhaust gas volume flow rate on wet basis  m³/h	G <sub>Fuel</sub>		kg/h
KH       Humidity correction factor       %         L       Percent torque related to maximum torque for the test mode       %         mass       Pollutant mass flow       g/h         nd,i       Engine speed (average at the i'th mode during the cycle)       1/min         Ps       Dry atmospheric pressure       kPa         Test ambient saturation vapor pressure at ambient temperature       kPa         P       Observed brake power output uncorrected       kW         PALUX       Declared total power absorbed by auxiliaries fitted for the test       kW         PM       Maximum power measured at the test speed under test conditions       kW         Pi       Pi = PM, i + PAUX, i       kW         PB       Total barometric pressure (average of the pre-test and post-test values)       kPa         Saturation pressure at dew point temperature       kPa         Ra       Relative humidity of the ambient air       %         S       Dynamometer setting       kW         T       Absolute temperature at air inlet       K         Total       Absolute temperature outlet (average)       K         Total       Absolute dewpoint temperature       K         Torque (average at the i'th mode during the cycle)       N-m         Tsc       Temperature	Н	Absolute humidity (water content related to dry air)	g/kg
L	i	Subscript denoting an individual mode	
mass       Pollutant mass flow       g/h         nd,i       Engine speed (average at the i'th mode during the cycle)       1/min         Ps       Dry atmospheric pressure       kPa         Pd       Test ambient saturation vapor pressure at ambient temperature       kPa         PO       Observed brake power output uncorrected       kW         PAUX       Declared total power absorbed by auxiliaries fitted for the test       kW         PM       Maximum power measured at the test speed under test conditions       kW         Pi	K <sub>H</sub>		
mass       Pollutant mass flow       g/h         nd,i       Engine speed (average at the i'th mode during the cycle)       1/min         Ps       Dry atmospheric pressure       kPa         Pd       Test ambient saturation vapor pressure at ambient temperature       kPa         PO       Observed brake power output uncorrected       kW         PAUX       Declared total power absorbed by auxiliaries fitted for the test       kW         PM       Maximum power measured at the test speed under test conditions       kW         Pi	L	Percent torque related to maximum torque for the test mode	%
Ps       Dry atmospheric pressure       KPa         Pd       Test ambient saturation vapor pressure at ambient temperature       kPa         P       Observed brake power output uncorrected       kW         PAUX       Declared total power absorbed by auxiliaries fitted for the test       kW         PM       Maximum power measured at the test speed under test conditions       kW         Pi       P, = PM. i + PAUX. i       KW         Ps       Total barometric pressure (average of the pre-test and post-test values)       kPa         Ra       Relative humidity of the ambient air       %         S       Dynamometer setting       kW         T       Absolute temperature at air inlet       K         Total       Absolute temperature atter the charge air cooler (if applicable) (average)       K         Total       Absolute dewpoint temperature       K         Total       Absolute dewpoint temperature       K         Total       Temperature outlet (average)       K         Td.       Torque (average at the i'th mode during the cycle)       N-m         Tsc       Temperature of the intercooled air       K         Tref.       Reference temperature       K         VEXHD       Exhaust gas volume flow rate on dry basis       m3/h	mass		g/h
Pd       Test ambient saturation vapor pressure at ambient temperature       kPa         P       Observed brake power output uncorrected       kW         Paux       Declared total power absorbed by auxiliaires fitted for the test       kW         PM       Maximum power measured at the test speed under test conditions       kW         Pi       Pi = PM.i + PAUX.i       r         Total barometric pressure (average of the pre-test and post-test values)       kPa         Pv       Saturation pressure at dew point temperature       kPa         Ra       Relative humidity of the ambient air       %         S       Dynamometer setting       kW         T       Absolute temperature at air inlet       K         T <sub>clout</sub> Coolant temperature after the charge air cooler (if applicable) (average)       K         T <sub>clout</sub> Coolant temperature outlet (average)       K         T <sub>Dd</sub> Absolute dewpoint temperature       K         T <sub>ort</sub> Torque (average at the i'th mode during the cycle)       N-m         T <sub>sc</sub> Temperature of the intercooled air       K         V <sub>EXHD</sub> Exhaust gas volume flow rate on dry basis       m³/h         V <sub>AIRW</sub> Intake air volume flow rate on wet basis       m³/h         V <sub>EXHW</sub> Exhaust gas volume	n <sub>d. i</sub>	Engine speed (average at the i'th mode during the cycle)	1/min
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	P <sub>s</sub>	Dry atmospheric pressure	kPa
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	P <sub>d</sub>	Test ambient saturation vapor pressure at ambient temperature	kPa
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	P	Observed brake power output uncorrected	kW
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	P <sub>AUX</sub>	Declared total power absorbed by auxiliaries fitted for the test	kW
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	P <sub>M</sub>		kW
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	P <sub>i</sub>	$P_i = P_{M,i} + P_{AUX,i}$	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	P <sub>B</sub>	Total barometric pressure (average of the pre-test and post-test values)	kPa
Ra     Relative humidity of the ambient air     %       S     Dynamometer setting     kW       T     Absolute temperature at air inlet     K       T <sub>bc</sub> Air temperature after the charge air cooler (if applicable) (average)     K       T <sub>clout</sub> Coolant temperature outlet (average)     K       T <sub>bd</sub> Absolute dewpoint temperature     K       T <sub>cl</sub> Torque (average at the i'th mode during the cycle)     N-m       T <sub>SC</sub> Temperature of the intercooled air     K       T <sub>erc</sub> Reference temperature     K       V <sub>EXHD</sub> Exhaust gas volume flow rate on dry basis     m³/h       V <sub>ARW</sub> Intake air volume flow rate on wet basis     m³/h       V <sub>EXHW</sub> Exhaust gas volume flow rate on wet basis     m³/h       V <sub>EXHW</sub> Exhaust gas volume flow rate on wet basis     m³/h	P <sub>v</sub>		kPa
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Ra		%
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	S	Dynamometer setting	kW
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			K
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	T <sub>be</sub>	Air temperature after the charge air cooler (if applicable) (average)	ĸ
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	T <sub>clout</sub>		K
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			ĸ
$ \begin{array}{llllllllllllllllllllllllllllllllllll$			N-m
Tref:     Reference temperature     K       Vexhd     Exhaust gas volume flow rate on dry basis     m³/h       Valrw     Intake air volume flow rate on wet basis     m³/h       P <sub>B</sub> Total barometric pressure     kPa       Vexhw     Exhaust gas volume flow rate on wet basis     m³/h			ĸ
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	Tref		ĸ
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	V <sub>EXHD</sub>		m³/h
P <sub>B</sub>			m³/h
V <sub>EXHW</sub> Exhaust gas volume flow rate on wet basis			1 ,
WE Weigning factor	WF		